

IN THE CLAIMS:

Please amend the claims of this application so as to read as follows:

1. (Currently Amended) A signal receiver receiving and demodulating a reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said signal receiver comprising:
 - a first memory adapted to store N (N is an integer of 2 or more) types of reference signals, each corresponding only to an arbitrary portion in said start symbol,
 - cross correlators adapted to calculate a cross correlation value between said reception signal and each of said N types of reference signals,
 - a peak position detector adapted to detect a peak position of each of the N cross correlation values calculated by said cross correlators,
 - a frequency offset estimation circuit adapted to estimate a frequency offset estimate value of a subcarrier of said reception signal for output, based on a cross correlation value at each of the N peak positions detected by said peak position detector, and
 - a frequency offset compensator adapted to compensate for a frequency offset of a subcarrier of said reception signal based on the frequency offset estimate value estimated by said frequency offset estimation circuit.

2. (Currently Amended) ~~The signal receiver according to claim 1,~~ A signal receiver receiving and demodulating a reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said signal receiver comprising:
- a first memory adapted to store N (N is an integer of 2 or more) types of reference signals, each corresponding to an arbitrary portion in said start symbol,
 - cross correlators adapted to calculate a cross correlation value between said reception signal and each of said N types of reference signals,
 - a peak position detector adapted to detect a peak position of each of the N cross correlation values calculated by said cross correlators,
 - a frequency offset estimation circuit adapted to estimate a frequency offset estimate value of a subcarrier of said reception signal for output, based on a cross correlation value at each of the N peak positions detected by said peak position detector, and
 - a frequency offset compensator adapted to compensate for a frequency offset of a subcarrier of said reception signal based on the frequency offset estimate value estimated by said frequency offset estimation circuit,

wherein

said frequency offset estimation circuit comprises
a phase rotation angle calculator adapted to
calculate a phase difference of cross correlation
values at each of said N peak positions,
a second memory adapted to store reference data based on a
phase rotation angle between cross correlation values
corresponding to said N types of reference signals under a
state where a particular frequency offset is present, and
a divider adapted to divide the phase difference of cross
correlation values calculated by said rotation angle
calculator by said reference data to calculate said frequency
offset estimate value.

3. (Previously Presented) The signal receiver according to claim 1, wherein said
frequency offset compensation circuit compensates for a frequency
offset by rotating the phase of a subcarrier of said reception signal
based on said estimated frequency offset estimate value.
4. (Previously Presented) The signal receiver according to claim 1, further comprising
a detector adapted to detect said reception signal, including a
local oscillator,
wherein said frequency offset compensation circuit comprises
a variable-controller adapted to variable-control an oscillation
frequency of said local oscillator based on said estimated
frequency offset value.

5. (Currently Amended) A signal receiver receiving and demodulating a reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said signal receiver comprising:

- a first memory adapted to store N (N is an integer of 3 or more) types of reference signals, each corresponding only to an arbitrary portion in said start symbol,
- cross correlators adapted to calculate a cross correlation value between said reception signal and each of said N types of reference signals,
- a peak position detector adapted to detect a peak position of each of the N cross correlation values calculated by said cross correlators,
- a frequency offset estimation circuit adapted to estimate and average a plurality of frequency offset estimate values of a subcarrier of said reception signal for output, based on a cross correlation value at each of the N peak positions detected by said peak position detector, and
- a frequency offset compensator adapted to compensate for a frequency offset of a subcarrier of said reception signal, based on the frequency offset estimate value estimated and averaged by said frequency offset estimation circuit.

6. (Currently Amended) ~~The signal receiver according to claim 5,~~ A signal receiver receiving and demodulating a reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said signal receiver comprising:
- a first memory adapted to store N (N is an integer of 3 or more) types of reference signals, each corresponding to an arbitrary portion in said start symbol,
 - cross correlators adapted to calculate a cross correlation value between said reception signal and each of said N types of reference signals,
 - a peak position detector adapted to detect a peak position of each of the N cross correlation values calculated by said cross correlators,
 - a frequency offset estimation circuit adapted to estimate and average a plurality of frequency offset estimate values of a subcarrier of said reception signal for output, based on a cross correlation value at each of the N peak positions detected by said peak position detector, and
 - a frequency offset compensator adapted to compensate for a frequency offset of a subcarrier of said reception signal, based on the frequency offset estimate value estimated and averaged by said frequency offset estimation circuit,

wherein

said frequency offset estimation circuit comprises
a plurality of phase rotation angle calculators
adapted to calculate phase differences of a plurality
of predetermined combinations of cross correlation
values at respective ones of said N peak positions,
a second memory adapted to store a plurality of reference
data based on a plurality of phase rotation angles
between cross correlation values corresponding to
said plurality of predetermined combinations of said
N types of reference signals under a state where a
particular frequency offset is present,
a plurality of dividers adapted to divide a plurality of phase
differences of cross correlation values calculated by
said plurality of rotation angle calculators by
respective corresponding ones of said plurality of
reference data to calculate a plurality of frequency
offset estimate values, and
an averager adapted to average a plurality of frequency
offset estimate values from said plurality of dividers
for output.

7. (Previously Presented) The signal receiver according to claim 5, wherein said
frequency offset compensation circuit compensates for a frequency
offset by rotating the phase of a subcarrier of said reception signal
based on said estimated and averaged frequency offset estimate
value.

8. (Previously Presented) The signal receiver according to claim 5, further comprising
a detector adapted to detect said reception signal, including a
local oscillator,
wherein said frequency offset compensation circuit comprises
a variable-controller adapted to variable-control an
oscillation frequency of said local oscillator based on said
estimated and averaged frequency offset estimate value.
9. (Previously Presented) A signal receiver receiving and demodulating a
reception signal formed of a data symbol section where symbols are
assigned in parallel to a plurality of subcarriers and modulated and a
start symbol added ahead of said data symbol section, said signal
receiver comprising:
a first memory adapted to store N (N is an integer of 2 or more)
types of reference signals, each corresponding to an
arbitrary portion in said start symbol,
cross correlators adapted to calculate a cross correlation value
between an applied first signal and each of said N types of
reference signals,
a peak position detector adapted to detect a peak position of each
of the N cross correlation values calculated by said cross
correlators,
a frequency offset estimation circuit adapted to estimate a
frequency offset estimate value of a subcarrier of said first
signal applied to said cross correlators for output, based
on a cross correlation value at each of the N peak positions
detected by said peak position detector, and accumulating
the frequency offset estimate values,

a phase rotator adapted to rotate a phase of a subcarrier of an applied second signal based on the frequency offset estimate value estimated by said frequency offset estimation circuit,

a second memory adapted to store said second signal whose phase is rotated by said phase rotator,

a controller adapted to execute once a first control operation of applying said reception signal to said cross correlators as said first signal and to said phase rotator as said second signal to accumulate frequency offset estimate values of a subcarrier of said reception signal, and rotating the phase of the subcarrier of said reception signal for storage in said second memory , and repeating (N - 1) times a second control operation of applying the signal stored in said second memory to said cross correlators as said first signal and to said phase rotator as said second signal to accumulate frequency offset estimate values of a subcarrier of the signal stored in said second memory, and rotating the phase of the subcarrier of the signal stored in said second memory for storage in said second memory , and

a frequency offset compensation circuit adapted to compensate for a frequency offset of the subcarrier of said reception signal based on an added value of N frequency offset estimate values accumulated by said first and second control operations.

10. (Previously Presented) The signal receiver according to claim 9, wherein said frequency offset compensation circuit compensates for a frequency offset by rotating the phase of the subcarrier of said reception signal based on the added value of said frequency offset estimate values.
11. (Previously Presented) The signal receiver according to claim 9, further comprising a detector adapted to detect said reception signal, including a local oscillator, wherein said frequency offset compensation circuit comprises a variable-controller adapted to variable-control an oscillation frequency of said local oscillator based on the added value of said frequency offset estimate values.
12. (Previously Presented) A signal receiver receiving and demodulating a reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said signal receiver comprising:
 - a first memory adapted to store N (N is an integer of 2 or more) types of reference signals, each corresponding to an arbitrary portion in said start symbol, and a plurality of reference data based on a phase rotation angle between cross correlation values corresponding to a plurality of sets of said reference signals, each set formed of two or more types of said reference signals, under a state where a particular frequency offset is present,

cross correlators adapted to calculate a cross correlation value
between an applied first signal and respective reference
signals of each said set,
peak position detector adapted to detect a peak position of each
cross correlation value calculated by said cross correlators,
a second memory adapted to extract and store a portion of said
reception signal,
a frequency offset estimation circuit adapted to estimate a
frequency offset estimate value of said first signal applied to
said cross correlators for output, based on a cross
correlation value at each peak position detected by said
peak position detector and reference data corresponding to
said reference signal of said each set,
an adder adapted to accumulate the frequency offset estimate
values output from said frequency offset estimation circuit,
a phase rotator adapted to rotate a phase of said reception signal
stored in said second memory, based on the frequency
offset estimate value estimated by said frequency offset
estimation circuit,

a controller adapted to execute a first control operation of applying said reception signal to said cross correlators as said first signal to calculate a cross correlation value with respective reference signals of a set corresponding to the smallest reference data of said plurality of reference data, and estimating a frequency offset estimate value of said reception signal by said frequency offset estimation circuit based on the calculated cross correlation value and said smallest reference data, and for repeating a second control operation of applying said reception signal whose phase is rotated based on said estimated frequency offset estimate value and stored in said second memory to said cross correlators as said first signal to calculate a cross correlation value with the set of reference signals corresponding to the smallest unused reference data from said plurality of reference data, and estimating a frequency offset estimate value of the signal stored in said second memory by said frequency offset estimation circuit, based on the calculated cross correlation value and said smallest unused reference data, and

a frequency offset compensator adapted to compensate for a frequency offset of the subcarrier of said reception signal based on an added value of frequency offset estimates accumulated by said adder and calculated by said first and second control operations.

13. (Previously Presented) The signal receiver according to claim 12, wherein said signal extracted from said reception signal and stored in said second memory is said start symbol.
14. (Previously Presented) The signal receiver according to claim 12, wherein said frequency offset compensation circuit compensates for a frequency offset by rotating the phase of a subcarrier of said reception signal based on the added result of said frequency offset values.
15. (Previously Presented) The signal receiver according to claim 12, further comprising a detector adapted to detect said reception signal, including a local oscillator, wherein said frequency offset compensation circuit comprises a variable-controller adapted to variable-control an oscillation frequency of said local oscillator based on the added value of said frequency offset estimate values.

16. (Currently Amended) A signal receiver receiving and demodulating a reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said signal receiver comprising:
- a carrier-to-noise ratio (C/N) detector adapted to detect a C/N of said reception signal,
 - a memory adapted to store a data table identifying an optimum reference signal corresponding to the C/N of said reception signal,
 - reference signal outputs adapted to provide N (N is an integer of 2 or more) types of optimum reference signals, each corresponding to an arbitrary portion in said start symbol, based on said data table according to said detected C/N,
 - a cross correlator adapted to calculate a cross correlation value between said reception signal and each of said N types of reference signals,
 - a peak position detector adapted to detect a peak position of each of the N cross correlation values calculated by said cross correlator,
 - a frequency offset estimation circuit adapted to estimate a frequency offset estimate value of a subcarrier of said reception signal for output, based on a cross correlation value at each of the N peak positions detected by said peak position detection means, and
 - a frequency offset compensator adapted to compensate for a frequency offset of the subcarrier of said reception signal, based on a frequency offset estimate value estimated by said frequency offset estimation circuit.

17. (Previously Presented) The signal receiver according to claim 16, wherein said frequency offset compensator compensates for a frequency offset by rotating the phase of the subcarrier of said reception signal based on said estimated frequency offset estimate value.

18 (Previously Presented) The signal receiver according to claim 16, further comprising a detector adapted to detect said reception signal, including a local oscillator, wherein said frequency offset compensator comprises a variable-controller adapted to variable-control an oscillation frequency of said local oscillator based on said estimated frequency offset estimate value.

19. (Currently Amended) A method of compensating for a frequency offset of a subcarrier of a reception signal in a signal receiver receiving and demodulating the reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said method comprising the steps of:

calculating a cross correlation value between said reception signal and each of N (N is an integer of 2 or more) types of reference signals, each corresponding only to an arbitrary portion in said start symbol,

detecting a peak position of each of said N calculated cross correlation values,

estimating a frequency offset estimate value of a subcarrier of said reception signal for output, based on a cross correlation value at each of said N detected peak positions, and

compensating for a frequency offset of the subcarrier of said reception signal based on said estimated frequency offset estimate value.

20. (Currently Amended) A method of compensating for a frequency offset of a subcarrier of a reception signal in a signal receiver receiving and demodulating the reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said method comprising the steps of:
- calculating a cross correlation value between said reception signal and each of N (N is an integer of 3 or more) types of reference signals, each corresponding only to an arbitrary portion in said start symbol,
 - detecting a peak position of each of said N calculated cross correlation values,
 - estimating and averaging a plurality of frequency offset estimate values of the subcarrier of said reception signal for output, based on the cross correlation value at each of said N detected peak positions, and
 - compensating for a frequency offset of the subcarrier of said reception signal, based on said estimated and averaged frequency offset estimate value.

21. (Original) A method of compensating for a frequency offset of a subcarrier of a reception signal in a signal receiver apparatus receiving and demodulating the reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said method comprising:
- a first control step, said first control step including the steps of
 - calculating a cross correlation value between said reception signal and each of N (N is an integer of 2 or more) types of reference signals, each corresponding to an arbitrary portion in said start symbol,
 - detecting a peak position of each of said N calculated cross correlation values,
 - estimating a frequency offset estimate value of the subcarrier of said reception signal, based on the cross correlation value at each of said N detected peak positions for output, as well as accumulating the estimated frequency offset estimate values,
 - rotating the phase of the subcarrier of said reception signal based on said estimated frequency offset estimate value, and
 - storing said phase-rotated reception signal,
 - said method further comprising a second control step, said second control step including the steps of
 - calculating a cross correlation value between said stored phase-rotated reception signal and each of said N types of reference signals,

detecting a peak position of each of said calculated cross correlation values,
estimating a frequency offset estimate value of the subcarrier of said stored phase-rotated reception signal for output, based on the cross correlation value at each of said N detected peak positions, as well as accumulating the estimated frequency offset estimate value,
rotating the phase of the subcarrier of said stored phase-rotated reception signal based on said estimated frequency offset estimate value, and
storing said phase-rotated reception signal,
said method comprising the steps of: repeating said second control step (N - 1) times after said first control step, and
compensating for a frequency offset by rotating the phase of the subcarrier of said reception signal based on an added value of the N frequency offset estimate values accumulated by said first and second control steps.

22. (Original) A method of compensating for a frequency offset of a subcarrier of a reception signal in a signal receiver receiving and demodulating the reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said method comprising:

a step of storing N (N is an integer of 2 or more) types of reference signals, each corresponding to an arbitrary portion of said start symbol, and a plurality of reference data based on phase rotation angles between cross correlation values corresponding to a plurality of sets of said reference signals, each set formed of two or more types of said reference signals, under a state where a particular frequency offset is present, and

a first control step, said first control step including the steps of

calculating a cross correlation value between said reception signal and respective reference signals of a set corresponding to the smallest reference data from said plurality of reference data,

detecting a peak position of each of said calculated cross correlation values,

estimating a frequency offset estimate value of the subcarrier of said reception signal, based on the cross correlation value at each of said detected peak positions and said smallest reference data for output, as well as accumulating the estimated frequency offset estimate values,

extracting and storing a portion of said reception signal, rotating the phase of said stored reception signal based on said estimated frequency offset estimate value, and

said method further comprising a second control step, said second control step including the steps of

- calculating a cross correlation value between said stored reception signal whose phase is rotated based on said estimated frequency offset estimate value, and respective reference signals of a set corresponding to the smallest unused reference data of said plurality of reference data,

- detecting a peak position of each of aid calculated cross correlation values,

- estimating a frequency offset estimate value of said phase-rotated stored reception signal for output, based on the cross correlation value at each of said detected peak positions and said smallest unused reference data, as well as accumulating the estimated frequency offset estimate values,

- repeating said second control step after said first control step, and

- compensating for a frequency offset by rotating the phase of the subcarrier of said reception signal based on an added value of the frequency offset estimate values accumulated by said first and second control steps.

23. (Original) A method of compensating for a frequency offset of a subcarrier of a reception signal in a signal receiver receiving and demodulating the reception signal formed of a data symbol section where symbols are assigned in parallel to a plurality of subcarriers and modulated and a start symbol added ahead of said data symbol section, said method comprising the steps of:
- detecting a C/N of said reception signal,
 - storing a data table identifying an optimum reference signal corresponding to the C/N of said reception signal,
 - providing N (N is an integer of 2 or more) types of optimum reference signals, each corresponding to an arbitrary portion in said start symbol, based on said data table, according to said detected C/N,
 - calculating a cross correlation value between said reception signal and each of said N types of reference signals,
 - detecting a peak position of each of said N calculated cross correlation values,
 - estimating a frequency offset estimate value of the subcarrier of said reception signal for output, based on the cross correlation value at each of said N detected peak positions, and
 - compensating for a frequency offset of the subcarrier of said reception signal based on said estimated frequency offset estimate value.